PB84-190602

Immunologic Effects of Electromagnetic Fields (1981-1983)

(U.S.) Health Effects Research Lab.
Research Triangle Park, NC

May 84

U.S. Department of Commerce
National Technical Information Service
NTIS

PB84-190602

EPA-600/D-84-124
May 1984

IMMUNOLOGIC EFFECTS OF ELECTROMAGNETIC FIELDS (1981-1983)

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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/D-84-124		PB84 190602

4. TITLE AND SUBTITLE	5. REPORT DATE
Immunologic Effects of Electromagnetic Fields (1981-1983)	May 1984
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Ralph J. Smialowicz PTB, DBD, HERL	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Health Effect Research Laboratory USEPA Research Triangle Park, NC 27711	ACSL1A
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
Office of Research & Development Health Effects Research Laboratory USEPA Research Triangle Park, NC 27711	14. SPONSORING AGENCY CODE EPA-600/11

15. SUPPLEMENTARY NOTES

16. ABSTRACT

In vitro studies provide evidence that support and EM field induced thermal mechanism for immune effects. When proper control of culture temperatures has been achieved during in vitro exposure to EM fields, no alterations have been observed for a variety of immune cell functions (Roberts et al., 1983; Sultan et al., 1983a, 1983b; Cain et al., 1981). There is conflicting evidence for effects on lymphocytes exposed in vitro to amplitude modulated EM fields at 60Hz (Lyle et al., 1983; Sultan et al., 1983b). More work is needed to determine if there exists a possible interaction between low frequency modulated EM fields and the immune system. At present, however,there is no convincing evidence from in vivo and in vitro animal studies that EM fields adversely alter the immune system at levels found in the ambient environment.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release to Public	Unclassified	10
	20. SECURITY CLASS *(This page)*	22. PRICE
	Unclassified	

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

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Over the past three years several reports have appeared in the literature dealing with the effects of electromagnetic (EM) fields on the immune system. This work has been motivated for the most part by a concern for possible adverse health effects of exposure to EM fields. Many of the studies in which animals have been exposed at various frequencies and intensities have reported inconsistent and transient changes in the functional integrity of the immune defense system. On the whole, direct comparisons among many of those studies are difficult to make because of differences in species, in exposure parameters, and in the immunologic endpoints examined. However, several generalizations can be made about the effects of EM fields on the immune system of animals.

Partial or whole-body exposure of animals to EM fields can lead both to stimulation or suppression of immune function. However, studies which have followed the effects over time have shown the alterations always to be reversible. For example, while thermogenic EM fields reversibly suppress natural killer (NK) cell activity in hamsters and mice, they reversibly enhance macrophage function in these same animals (Yang et al., 1983; Rama Rao et al., 1983; Smialowicz et al., 1983). Suppression of NK cell activity by thermogenic EM fields may be one of the factors involved in the recently described accelerated development of benzopyrene-induced skin cancer and spontaneous breast cancer in mice exposed to EM fields (Szmigielski et al., 1982). NK cells play a role as one of the first lines of defense against neoplasias. Szmigieski et al. (1982) found a similar acceleration of cancer development in mice exposed to a prolonged nonspecific stress compared with EM field exposure. Consequently, an EM-induced thermal stress mechanism for the observed effects is not beyond

reason because of the known effects of thermal stress on NK cells (Yang et al., 1983; Smialowicz et al., 1983) and nonspecific stress in general on the immune response against tumors (Riley, 1981).

Many of the observed EM field alterations in the immune system can be attributed to a nonspecific thermal stress response, because qualitatively similar but quantitatively greater changes are observed at obviously stressful (highly thermalizing) EM field levels or following the administration of glucocorticoids (Yang et al., 1983; Rama Rao et al., 1983; Smialowicz et al., 1981a, 1983; Roszkowski et al., 1981; Riddle et al., 1982). EM field-induced changes in B lymphocyte subpopulations also appear to result from heating (Smialowicz et al., 1981a) and are dependent upon the age and strain of mouse emp'oyed (Schlagel and Ahmed 1982), the EM field characteristics, and the environmental conditions (Smialowicz et al., 1981a). Thermogenic EM fields affect not only the mature immune system but also the developing immune system (Smialowicz et al., 1982; Chazan et al., 1983).

The fact that an increase in deep body temperature (e.g., colonic temperature) is not observed during or following exposure to EM fields does not preclude a thermal interaction that the animal is able to compensate for and control (Smialowicz, 1983). Comparison of specific absorption rates among various studies at which effects on the immune system have been reported provides a strong indictment for EM field induced heating as the predominant if not the only underlying factor responsible for the observed effects. The failure to observe immune effects at non-thermogenic EM field levels (Yang et al., 1983; Rama Rao et al., 1983; Smialowicz et al., 1981, 1982, 1983; Riddle et al., 1982) even after prolonged periods of exposure

(Smialowicz et al., 1981b, 1981c; Morris and Phillips, 1982) provides further evidence for a thermal mechanism.

In vitro studies also provide evidence that support an EM field induced thermal mechanism for immune effects. When proper control of culture temperatures has been achieved during in vitro exposure to EM fields, no alterations have been observed for a variety of immune cell functions (Roberts et al., 1983; Sultan et al., 1983a, 1983b; Cain et al., 1981). There is conflicting evidence for effects on lymphocytes exposed in vitro to amplitude modulated EM fields at 60Hz (Lyle et al., 1983; Sultan et al., 1983b). More work is needed to determine if there exists a possible interaction between low frequency modulated EM fields and the immune system. At present, however, there is no convincing evidence from in vivo and in vitro animal studies that EM fields adversely alter the immune system at levels found in the ambient environment.

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